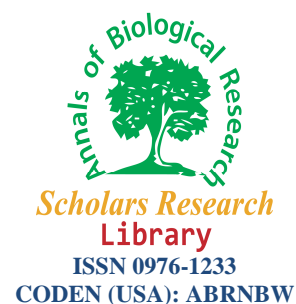




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Effect of Humic Acid on Yield and Quality of Marigold (*Calendula officinalis* L.)

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ABSTRACT

To study the effect of humic acid on yield and yield components of marigold, a complete randomized experiment with 5 levels of humic acid treatments (0, 500, 1000, 2000, 4000 mgL⁻¹) with 3 replications and 15 experimental plots was carried out. Analysis of variance showed that the effect of humic acid treatments on number of leaves and flowers, dry weight and plant height was significantly at the 1% probability level. Mean comparisons revealed that treatment with 2000 mgL⁻¹ humic acid, had the most dry weight, plant height, leaves and flowers number.

Keywords: humic acid, *Calendula officinalis*, dry weight, plant height

INTRODUCTION

Marigold (*Calendula officinalis* L.) belongs to Asteraceae family, is a medicinal - ornamental herbaceous annual plant which is originated from Mediterranean and West Asia. The active substance of this plant is made and stored in its yellow and orange flowers; the most important ones are: flavonoids, carotenoids, essential oils, mucilage substances and vitamin A. This plant is used to Plants to treat diseases of the stomach, intestines, and also, the flowers extract is used to dye some types of foods and fats [12]. Indiscriminate use of chemical fertilizers destructs soil chemical and physical texture and in the long term, consequences will be irreversible which reduced plant yield [2, 8]. Use of humic acid and bio-fertilizers is proposed to modify soil texture, soil structure integrity, aeration and increase nutrient absorption. Humic acid is a commercial product containing abundant nutrients improves soil fertility and increase the availability of nutrients to plants and thus it influences plant growth and yield [3, 9, 14]. Rutan & Schnitzer [13] found that humic acid containing compounds in hoagland solution, increased nitrogen uptake and improved overall yield in cucumber (*Cucumis sativus* L). Cimrin & Yilmaz [4] reported that the use of humic acid and chemical fertilizers improves nutrient absorption in lettuce (*Lactuca sativa*). The aim of this study is to investigate the effect of humic acid on yield and yield components of marigold.

MATERIALS AND METHODS

Marigold seedlings (*Calendula officinalis* L.) are purchased from a greenhouse in Amol and were subjected to humic acid treatments (0, 500, 1000, 2000, 4000 mgL⁻¹) on the basis of complete randomized experimental design with 5 treatments in 3 replications and 5 seedlings per plot. The measured traits were number of leaves and flowers, dry weight and plant height. After harvesting, number of leaves and flowers of plants in each plot were evaluated using visual counts. After measuring fresh weight, flowers were placed in 72°C oven and after 24 hours, dry weight

was measured. Both fresh and dry weight was measured with a digital scale with an accuracy of 0.01 g. At flowers harvest time (when the flowers were wilted and had lower marketable yields) plant height was measured from the soil surface to the tip of flowers using the ruler. Data were subjected to analysis of variance using SPSS and MSTATC software and mean comparisons was performed according to LSD test.

RESULTS AND DISCUSSION

Analysis of variance showed that the effect of humic acid treatments on all measured traits was significant at 1% probability level. Humic acid effect on plant height showed that treatment with 2000 mgL⁻¹ was the best treatment (45.27 cm), and the control (55.18 cm) was the worst treatment. Singh et al [16] found that the use of bio-fertilizers improved yield and and yield-related indexes in marigold (*Calendula officinalis* L.). The results of present study showed that the organic media can improve plant height. This can be due to increased media moisture storage and enhanced nutrient absorption [15]. Kamari Shahmaleki et al. [7] found that treatment with 20 & 50 mgL⁻¹ humic acid in lettuce increased characteristics significantly. Our results about the positive impact of humic acid on the growth and yield indexes in watermelon (*Citrulus lanatus*) and pumpkin (*Cucurbita maxima*) is in accordance with the results of Hafez [6]. Humic acid effect on the number of leaves showed that 2000 mgL⁻¹ with 46.02 leaves per plant was the best treatment and control with 30.67 leaves per plant was the least effective one. In present study, humic acid in high concentrations, increased the number of leaves which could be due to positive mineral effect and also hormone-like activity of humic acid on vegetative growth [7]. Elkhateeb et al. [5] stated that the use of inoculative bio-fertilizers and humic acid significantly increased leaf area in acacia (*Acacia saligna*) as compared to the control. Also, humic acid effect on the dry weight showed the priority of 2000 mgL⁻¹ with 215.7 g rather than the control (141.26 g). The positive effect of humic acid's ability to nutrients absorption could be because of it's effect on plant dry biomass which confirms Kamari Shahmaleki [7] and Abdel-Mawgoud [1]. Humic acid effect on the number of flowers showed that treatment with 2000 mgL⁻¹ increased the number about 6 units as compared to the control (27.13 flowers & 18.45 folwers, respectively). Nikbakht et al. [11] reported that 500 mgL⁻¹ humic acid caused a 52% yield increase gerbera flowers (*Gerbera Jamesonii* L.). Morard et al. [10] reported that humic acid increases yield and flowers nuber in leaf area unit with nutrients absorption and its hormone-like properties which is in close agreement to our results.

Table 1 - Effect of humic acid on the measured traits of marigold (*Calendula officinalis* L.)

Treatments	Seedling height (cm)	Leaves number	Flowers number	Dry weight (g)
H ₁	18.55 c	30.67c	18.43d	141.26c
H ₂	22.61b	38.01b	23.59bc	175.66b
H ₃	24.37ab	40.09b	25.33ab	187.70b
H ₄	27.45a	46.00a	27.13a	215.07a
H ₅	22.05b	37.44b	20.70cd	171.36b

H₁: control; H₂: 500 mgL⁻¹ humic acid; H₃: 1000 mgL⁻¹ humic acid; H₄: 2000 mgL⁻¹ humic acid; H₅: 4000 mgL⁻¹ humic acid. In each column, means with a common letter are significant based on the LSD test.

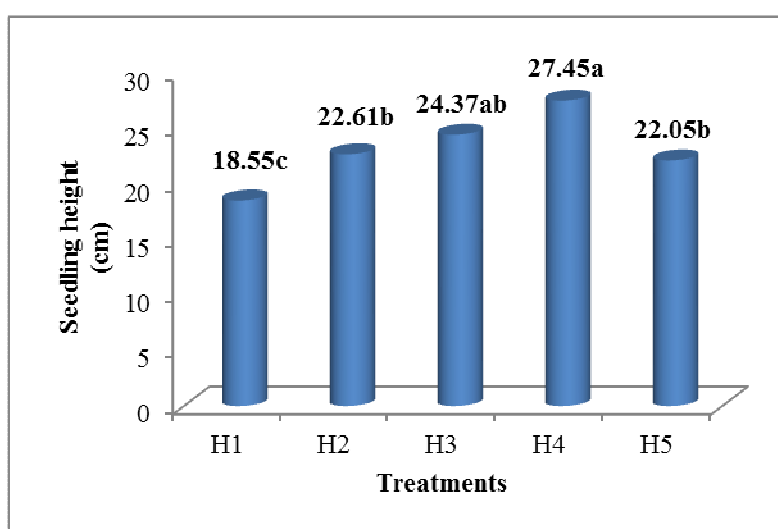


Fig 1. Effect of different humic acid levels on seedling height of *Calendula officinalis* L.

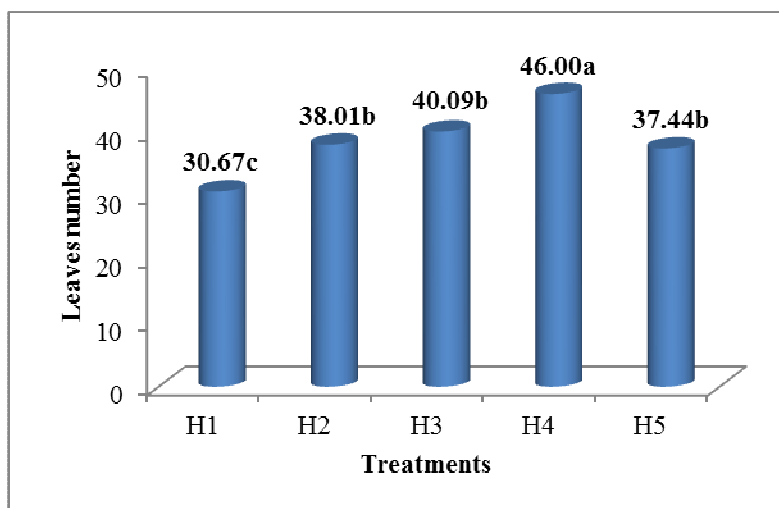


Fig 2. Effect of different humic acid levels on leaves number of *Calendula officinalis* L.

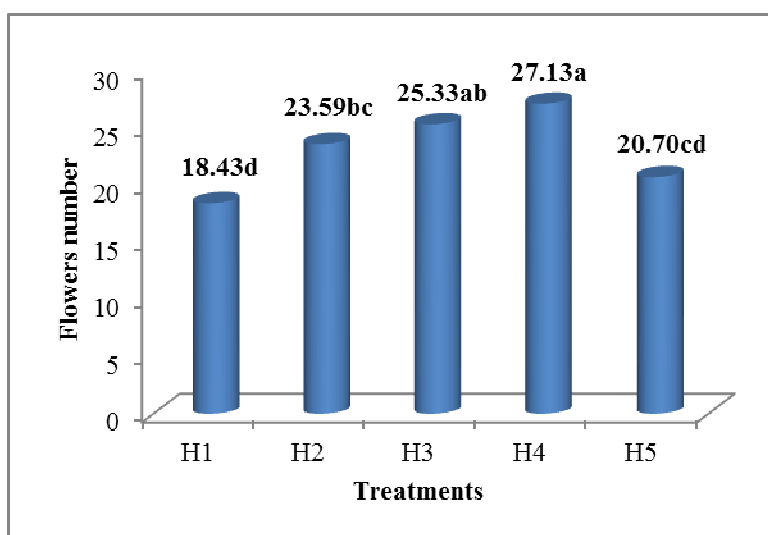


Fig 3. Effect of different humic acid levels on flowers number of *Calendula officinalis* L.

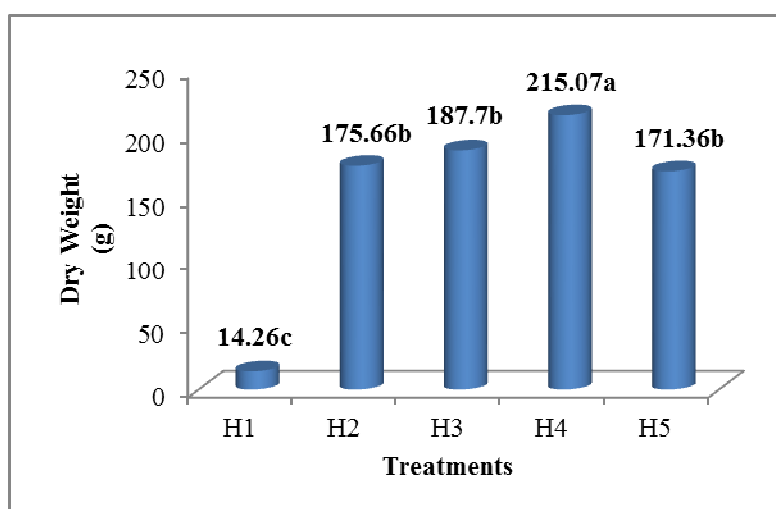


Fig 4. Effect of different humic acid levels on dry weight of *Calendula officinalis* L.

CONCLUSION

In conclusion effect of humic acid on yield and yield components of marigold was positive and this organic fertilizer can be used in future.

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